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A Model of R&D Capitalization

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Abstract

This paper studies the decision of firms to expense or capitalize R&D expenditures. The firm has an incentive to mismatch the benefits and costs of R&D, expensing a larger portion of R&D when the benefits occur in the long-run and capitalizing a larger portion when the benefits occur in the short-run. There is strategic substitutability between R&D investments and expensing. Accounting standards, market evaluation of capitalization, and firms' accounting policies can have real effects on innovation.

Key words: R&D; innovation; expensing; capitalization; accounting standards

JEL classification: L21; M41; O32

1. Introduction

An R&D expenditure can be treated in two ways. It can be expensed—that is, all the outlay is classified as an expense for the current period, reducing current profits by the total amount. Alternatively, it can be capitalized—that is, a portion of the total expenditure is expensed in the current period, while a portion is reported as expenses in future periods; this leads to higher current profits and lower future profits. The purpose of this paper is to model the accounting treatment of R&D expenditures and to analyze its effect on innovation.

Since 1974, the *U.S. Statement of Financial Accounting Standard* (2) favors the expensing of R&D expenditures. In Canada, according to Section 3450, *Research and Development Costs*, of the Canadian Institute of Chartered Accountants Handbook, firms have to capitalize development costs meeting certain criteria and to expense all other development as well as research costs. A similar approach is taken

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by the International Accounting Standard (IAS 38). Most OECD countries allow full expensing (Guellec and de la Potterie, 1997).

On the face of it, the law seems to leave little choice to the firm as to the accounting treatment of R&D. However, in reality, firms have a high degree of latitude (Palepu et al., 2000). Manipulation can be done, for example, through the assessment of the types of costs satisfying the criteria or in the estimates of the expected longevity of amortized outlays. As Callimaci and Landry (2003, p. 134) note: "the application of the criteria for capitalization is based on management judgment and involves a considerable amount of subjectivity."

Even though capitalization increases current profits and can constitute a signal to investors about the future technological benefits of R&D (Cazavan-Jeny and JeanJean, 2003), firms use this accounting tool with extreme care for the simple reason that markets dislike capitalization. Investors often consider capitalization as a way for the firm to artificially boost its current profits. In other words, capitalization reduces the quality of profits. Given that not all R&D benefits occur in the first period of invention, immediate expensing induces faster financial reporting of costs than of benefits. Moreover, expensing reveals strategic information about R&D projects to competitors, and there is evidence that this is a concern for executives (Entwistle, 1999). In addition, when a firm is listed on more than one stock exchange (e.g., Canadian firms listed on both the U.S. and Canadian stock exchanges), it is easier for the firm to follow a single accounting method across jurisdictions.

In practice firms do capitalize a portion of their R&D expenditures. Callimaci and Landry (2003) find that about 28% of firms in a sample of hi-tech and biopharmaceutical firms capitalize a portion of their R&D spending. They find that capitalization increases with leverage (to reduce the debt-to-assets ratio), firm age, and cash flows. It decreases with firm size, concentration of ownership, and profitability. Contrary to expectations, they find that Canadian cross-listed firms are more likely to capitalize their R&D expenditures. Ding et al. (2003) report that Canadian firms are slightly more likely to capitalize R&D expenditures compared to French firms, although the difference is not statistically significant.

Entwistle (1999) interviewed 21 executives from leading Canadian technology firms and 15 of Canada's top technology analysts. The majority of executives and analysts opposed capitalization for numerous reasons, including the desire to avoid negative perceptions of the firm, the difficulty of managing future write-downs, the difficulty of evaluating technology with sufficient precision, cross-listing with the U.S. stock exchange, and a preference for conservative accounting. The minority of executives preferring capitalization did so for reasons related to the continuity of accounting practices, the desire to match costs to benefits, and control over financial results. Some analysts were unopposed to capitalization, but only under certain conditions: the firm has a good R&D track record and the deferred amount is small relative to total R&D outlays.

Schankerman (1981), in an analysis of the contribution of R&D to economic growth, examines the bias that arises from expensing. For U.S. manufacturing firms

during the periods 1958–1966 and 1967–1976, he finds that R&D expensing results in an upward bias on the order of 16–23% of the true residual when a growth accounting framework is used. However, with production function estimation, the expensing bias is downward and significant (16%). These results show that accounting rules can have real effects on variables of economic interest, even when R&D is taken as given.

While there is an extensive accounting literature dealing with the incentives for, and the empirical evidence on, R&D capitalization, there is no formal economic model dealing with this issue. In order to fill this gap, the current paper models the capitalization decision of a monopolist. There are two periods, with output and sales taking place in each period. Decisions are made in two stages. In the first stage, the firm decides on how much to invest in R&D and on its accounting policy. All the investment in R&D occurs in the first period. Part of the reduction in marginal costs occurs in the first period; this represents the short-term benefit of R&D. The full reduction in marginal costs occurs only in the second period; this represents the long-term benefits from R&D, which can exceed the short-term benefits. In the second stage, the firm makes its output decisions, determining a level of output for each period.

The benefits of capitalization are captured by discounting future profits: everything else being equal, capitalization increases total discounted profits. However, capitalization has a cost, representing the negative attitude of the stock market toward that practice. This cost is captured through a general function. Having derived the profit-maximizing investment in R&D and accounting policy, the model goes on to analyze the effects of the following parameters on innovation and capitalization: the speed with which the benefits of R&D occur, production costs, demand, the speed with which the market reacts to capitalization, the discount factor, R&D costs, and the total cost of capitalization.

One major result of the model is that there is strategic substitutability between R&D investments and expensing. On the one hand, a higher level of expensing reduces the marginal benefit of R&D because the total discounted costs of R&D have increased. On the other hand, a higher level of R&D makes expensing more costly by reducing today's marginal profits from expensing more than it increases tomorrow's marginal profits from expensing. This strategic substitutability helps one understand the comparative statics of the model and in particular why many parameters affect R&D expenditures and expensing in opposite directions.

The other major findings of the model are as follows. R&D projects whose benefits occur mainly in the short-run are less likely to be expensed. Hence the firm has an incentive to mismatch the benefits and costs of R&D, expensing projects which are beneficial (only) in the long-run and capitalizing projects which are beneficial (also) in the short-run. Smaller firms are more likely to expense a larger portion of their R&D expenditures because they have a smaller R&D budget. A faster reaction of markets to expensing reduces it. An increase in the discount factor, although having a negative direct effect on expensing, has a net ambiguous effect because of its effect on R&D. The cost of R&D has an ambiguous effect on

expensing. Overall, the model argues that looser accounting standards and a less conservative market evaluation of capitalization can favor innovation.

Given that R&D is endogenous to the model, the effects of these changes on innovation and its interaction with expensing are also derived. Some of these changes result from a direct effect of the parameters on expensing, while in some other cases the effect comes indirectly through the impact of the parameter on R&D investment and the impact of R&D on expensing.

One may think that expensing is purely an accounting issue, with no effect on real variables and hence of little interest to economists (as it does not affect the real economy). The model shows that this belief is unfounded. First, the strategic interaction between expensing and R&D implies that expensing policy has a direct effect on R&D expenditures. Second, the model shows that the cost of capitalization affects R&D investments negatively because it increases the real cost of any R&D outlay. Finally, the cost of R&D affects expensing and hence has an indirect effect on R&D investment through its effect on expensing. Therefore, the accounting policy of the firm, accounting standards, and the reaction of markets to capitalization decisions all have real effects on innovation.

This is not the first paper to argue that accounting rules can have real economic consequences. Linhart et al. (1974) model the impact of the capitalization decision for investments by regulated and unregulated firms. They show that tax collectors, firms' owners, and consumers are not indifferent between expensing and capitalization.

The paper is organized as follows. The model is presented and solved in Section 2. The comparative statics and the analysis are taken up in Section 3. Section 4 concludes.

2. The Model

There are two production/sales periods. The firm makes its decisions in the following order. In the first stage, the firm decides on the amount to invest in R&D and on its expensing policy. In the second stage, the firm decides on each period's output. Crucial to the model is the distribution of the costs and benefits (reduction in marginal costs) of R&D investments and R&D disclosure over time. All R&D investments are made in the first period. Part of the reduction in marginal costs occurs in the first period (λ), and only in the second period is all the cost reduction obtained. The intertemporal distribution of the reduction in marginal costs is inherent to the disclosure decision. Absent this intertemporal distribution, the firm would have no justification in capitalizing a portion of R&D expenditures (the reader should avoid confusing "R&D expenditures" with "R&D expensing").

As for disclosure, the firm decides which proportion of the investment is expensed (α) and which proportion is capitalized ($1-\alpha$). The market will respond to any capitalization negatively (it is true that some performance measures may actually worsen with capitalization, e.g., the return on investment. But here we focus on the effect on profits, and this will have adverse effects on the firm's profits: an

increase in the cost of capital, a decline in market value, an increase in the dividends that have to be paid to attract investors, etc.) These costs are represented by the function $\beta\theta(\alpha)$, with $\beta > 0$, $\theta'(\alpha) < 0$, and $\theta''(\alpha) > 0$. A portion (η) of these disclosure-related costs is incurred in the first period, while the remainder ($1-\eta$) is incurred in the second period. The firm faces a linear inverse demand in each period $p_t = A - y_t$, with independent demands between periods. The total cost of R&D output level x is represented by a convex and increasing function $\gamma(\xi, x)$, where ξ is a cost parameter and $\xi > 0$, $\gamma_x > 0$, $\gamma_{xx} > 0$, and $\gamma_{x\xi} > 0$.

The firm's profits (the model implicitly assumes that capital markets react mainly to accounting profits, not economic profits) in the first period are:

$$\pi_1(y_1, x, \alpha) = (p_1(y_1) - c_1)y_1 - \alpha\gamma(\xi, x) - \eta\beta\theta(\alpha). \quad (1)$$

Profits in the second period are:

$$\pi_2(y_2, x, \alpha) = (p_2(y_2) - c_2)y_2 - (1-\alpha)\gamma(\xi, x) - (1-\eta)\beta\theta(\alpha). \quad (2)$$

Total profits are the discounted sum of per period profits:

$$\pi_T(y_1, y_2, x, \alpha) = \pi_1 + \delta\pi_2, \quad (3)$$

where $\delta \in [0, 1]$ is the discount factor.

The firm's marginal costs in the first and second periods are, respectively:

$$\begin{aligned} c_1 &= R - \lambda x, \\ c_2 &= R - x, \end{aligned} \quad (4)$$

where R is the initial marginal cost when no R&D is undertaken. In the first period, only the portion $\lambda \in [0, 1]$ of total cost reduction is usable by the firm. In the second period, the firm benefits fully from the advantages of the new technology.

In the second stage the firm chooses its first period and second period output:

$$\max_{y_1, y_2} \pi_T(y_1, y_2, x, \alpha). \quad (5)$$

Given that no interaction arises between the choices of y_1 and y_2 , the results would be the same if that stage was broken into two distinct stages. It is straightforward to verify that this yields the following levels of output:

$$y_1^* = \frac{A - R + \lambda x}{2} \quad \text{and} \quad y_2^* = \frac{A - R + x}{2}. \quad (6)$$

Substituting the optimal values of output into total profits yields:

$$\pi_T^*(x, \alpha) = \frac{(A - R + \lambda x)^2 + \delta(A - R + x)^2}{4} - \gamma(\xi, x)[\alpha + \delta(1 - \alpha)] - \beta\theta(\alpha)[\eta + \delta(1 - \eta)]. \quad (7)$$

Consider now the first stage, where the firm chooses R&D investment and disclosure policy to maximize total profits:

$$\max_{x, \alpha} \pi_T(y_1^*(x), y_2^*(x), x, \alpha). \quad (8)$$

We consider interior solutions where $\alpha \in (0,1)$. Such an interior solution requires that the cost of capitalization, $\beta\theta(\alpha)$, be neither too low (in which case the firm would choose $\alpha = 0$) nor too high (as it would then choose $\alpha = 1$). The empirical evidence presented in the introduction indicates that a large number of firms capitalize a positive portion, but not 100%, of their R&D expenditures. This supports the focus on an interior solution. Solving this problem we obtain the following two first-order conditions:

$$\frac{\partial \pi_T}{\partial x} = \frac{\lambda(A - R + \lambda x) + \delta(A - R + x)}{2} - \gamma_x[\alpha + \delta(1 - \alpha)] = 0, \quad (9)$$

$$\frac{\partial \pi_T}{\partial \alpha} = \gamma(\xi, x)(\delta - 1) - \beta\theta'(\alpha)[\eta + \delta(1 - \eta)] = 0. \quad (10)$$

Equation (9) equates the sum of marginal benefits of R&D investment, represented by the increase in revenues in the first and second periods, with the sum of marginal costs of R&D distributed over the two periods according to the expensing level α . Equation (10) equates the marginal gains from capitalization, represented by the decrease in the total discounted cost of R&D, with the marginal cost of capitalization, represented by $\beta\theta'(\alpha)$ distributed over the two periods. For notational brevity we define $z(\alpha) = \alpha + \delta(1 - \alpha)$ and $z(\eta) = \eta + \delta(1 - \eta)$.

The second-order conditions for profit maximization are:

$$\frac{\partial^2 \pi_T}{\partial x^2} = \frac{\lambda^2 + \delta}{2} - \gamma_{xx}z(\alpha) < 0, \quad (11)$$

$$\frac{\partial^2 \pi_T}{\partial \alpha^2} = -\beta\theta''(\alpha)z(\eta) < 0. \quad (12)$$

3. Comparative Statics

The strategic interaction between R&D expenditures and expensing is crucial to understand the comparative statics of the model. R&D expenditures and expensing are strategic substitutes:

$$\frac{\partial^2 \pi_T}{\partial x \partial \alpha} = \frac{\partial^2 \pi_T}{\partial \alpha \partial x} = (\delta - 1)\gamma_x < 0. \quad (13)$$

On the one hand, an increase in expensing increases the discounted cost of R&D investments, reducing the marginal profitability from innovation. When

expensing increases, today's marginal profits (with respect to R&D) are reduced by γ_x , while tomorrow's marginal profits are increased by $\delta\gamma_x$. The decline in marginal profits is more important than the gain; hence the marginal profitability of an additional unit of R&D is reduced. On the other hand, an increase in R&D investment makes expensing more costly. The increase in R&D investment reduces today's marginal profits (with respect to α) by γ_x and increases tomorrow's marginal profits by $\delta\gamma_x$. The decline in today's marginal profits is more important than the increase in tomorrow's marginal profits, reducing the marginal profitability of expensing.

In the reminder of the paper we analyze the impact of changes in the environment on innovation and disclosure. We consider, in this order, an increase in the short-term benefits of R&D, in production costs, in the size of the market, in the short-term response of the market to the firm's disclosure policy, in the discount factor, in R&D investment costs, and in the costs of capitalization.

Despite the simplicity of the model it turns out that the comparative statics of R&D expenditures with respect to the short-term benefits of R&D, the discount factor, and R&D costs are difficult to sign. To rule out pathological but irrelevant cases and to focus the analysis on R&D capitalization we use the following axiom.

Axiom 1: An increase in the short-term benefits of R&D (λ), an increase in the discount factor (δ), or a decrease in the cost of R&D (ξ) increases R&D investment.

This axiom is quite intuitive. An increase in the short-term benefits of R&D increases the benefits of innovation without inducing any additional costs; hence it cannot reduce R&D investment (this increase in short-term benefits is *not* at the expense of long-term benefits: in the long-run the firm always obtains the full benefits of R&D). An increase in the discount factor increases the importance of the future, increasing the gains from innovation again without inducing any additional costs. Finally, a decrease in the cost of R&D makes R&D more profitable, hence it must increase innovation. This axiom will be used in the comparative statics that follow.

Consider first the effect of an increase in the short-term benefits of R&D. A higher value of λ represents an increase in the portion of the benefits of the technology which occur immediately after the innovation is made. Totally differentiating Equations (9) and (10) and making the appropriate substitutions yields:

$$\frac{dx}{d\lambda} = -\frac{0.5(A-R) + \lambda x}{F + \frac{[\gamma_x(1-\delta)]^2}{\beta\theta''(\alpha)z(\eta)}} > 0, \quad (14)$$

where $F = 0.5(\lambda^2 + \delta) - \gamma_{xx}z(\alpha)$ (note that $F < 0$ by (11)). The numerator is positive, the first term in the denominator is negative, and the last term in the denominator is

positive. Hence the sign of the denominator is a priori ambiguous. The overall expression is positive by Axiom 1 (see above). Note that this implies that the denominator is negative. We will use this result later.

Consider now the effect of an increase in the short-term benefits of R&D on disclosure:

$$\frac{d\alpha}{d\lambda} = \frac{\gamma_x(\delta-1)}{\beta\theta''(\alpha)z(\eta)} \frac{dx}{d\lambda} < 0. \quad (15)$$

The numerator of the first factor is negative, while the denominator is positive; therefore the whole expression is negative. An increase in the short-term benefits of R&D increases R&D investment, reducing the profitability of expensing and increasing capitalization. Paradoxically, when the benefits of the technology occur mainly in the short-run, so that a matching between the timing of reporting of benefits and costs would require expensing, the firm capitalizes a larger portion of the R&D outlay. This occurs because of the strategic substitutability of R&D expenditures and expensing. The incentives of the firm go against the objective of matching the benefits and costs of R&D over time.

Proposition 1: An increase in the short-term benefits of R&D increases innovation and reduces expensing.

Consider next the impact of an increase in initial production costs, R . Totally differentiating Equations (9) and (10) and making the appropriate substitutions yields:

$$\frac{dx}{dR} = \frac{0.5(\lambda + \delta)}{F + \frac{[\gamma_x(1-\delta)]^2}{\beta\theta''(\alpha)z(\eta)}} < 0. \quad (16)$$

The numerator is positive, while the denominator is negative by (14). It follows that an increase in production costs leads to a reduction in innovation because the firm sells a smaller amount of output to which the innovation can be applied.

The change in production costs also affects expensing:

$$\frac{d\alpha}{dR} = \frac{\gamma_x(\delta-1)}{\beta\theta''(\alpha)z(\eta)} \frac{dx}{dR} > 0. \quad (17)$$

The first factor is negative, implying that the effect of an increase in costs on expensing is positive. Because of the strategic substitutability of expensing and R&D investment, the decrease in R&D investment following an increase in production costs triggers an increase in expensing. Given that cost is negatively associated with firm size, this suggests that larger firms will expense a smaller portion of their R&D expenditures.

Note that an increase in the market size (A) has exactly the opposite effect of an increase in R : it increases innovation and reduces expensing.

Proposition 2: An increase in the firm's marginal production cost or a reduction in demand reduces innovation and increases expensing.

Given that costs tend to be higher during expansions, the positive relationship between costs and expensing suggests that expensing is pro-cyclical: firms would expense a smaller portion of their R&D expenditures during recessions, and a larger portion during expansions. In contrast, the negative relationship between demand and expensing suggests that expensing is counter-cyclical.

Consider now an increase in the short-term costs of capitalization. The total (undiscounted) loss from capitalization remains unchanged, but now markets react faster, inducing a greater loss in profits in the short term and a smaller loss in the long-term. The effect on expensing is given by the following expression:

$$\frac{d\alpha}{d\eta} = -\frac{\beta\theta'(\alpha)(1-\delta)}{\frac{[\gamma_x(1-\delta)]^2}{F} + \beta\theta''(\alpha)z(\eta)} > 0. \quad (18)$$

The numerator is negative, while the denominator is positive by (14). The increase in the short-term loss from capitalization, while decreasing the long-term loss, increases the total discounted loss from capitalization, inducing an increase in expensing.

The change in short-term capitalization costs also affects innovation:

$$\frac{dx}{d\eta} = \frac{\gamma_x(1-\delta)}{F} \frac{d\alpha}{d\eta} < 0. \quad (19)$$

The numerator of the first factor is positive, while the denominator is negative. Hence, an increase in the short-term costs of expensing reduces innovation. This is related to the strategic substitutability between R&D investment and expensing. The increase in expensing induced by the increase in η triggers a reduction in R&D investment.

Proposition 3: An increase in the short-term costs of capitalization reduces innovation and increases expensing.

Consider next the effect of an increase in the discount factor, δ :

$$\frac{dx}{d\delta} = -\frac{\beta\theta''(\alpha)z(\eta)[0.5(A-R+x)-\gamma_x(1-\alpha)] + \gamma_x(1-\delta)[\gamma(\xi, x) - \beta\theta'(\alpha)(1-\eta)]}{F\beta\theta''(\alpha)z(\eta) + [\gamma_x(1-\delta)]^2} > 0. \quad (20)$$

The sign of the numerator is a priori ambiguous, the denominator is negative by (14), and the overall expression is positive by Axiom 1 (see above). Note that Axiom 1 is

needed to sign this expression, which turns out to be too complex to sign otherwise. Hence an increase in the discount factor increases innovation. The increase in δ increases the importance of the future, increasing the weight of second period revenues (and costs) in the total profit function, which increases the benefits from innovation.

The effect of the discount factor on expensing is:

$$\frac{d\alpha}{d\delta} = \frac{\gamma(\xi, x) - \beta\theta'(\alpha)(1-\eta) + \gamma_x(\delta-1)\frac{dx}{d\delta}}{\beta\theta''(\alpha)z(\eta)}. \quad (21)$$

The denominator is positive, the sum of the first two terms in the numerator is positive, while the third term is negative; therefore, the total effect is ambiguous. The first two terms in the numerator represent the direct effect of δ on expensing: the increase in δ increases tomorrow's costs by $\gamma(\xi, x) - \beta\theta'(\alpha)(1-\eta)$, i.e., the increase in the importance of R&D costs plus the future portion of the cost of capitalization. This direct effect is positive: an increase in the discount factor increases the importance of future profits compared to current profits, which induces an increase in expensing. However, the increase in R&D investment has a negative effect on α : this effect is captured by the third term in the numerator, which is negative. The net effect of an increase in the discount factor on expensing depends on whether the direct positive effect or the indirect negative effect dominates.

Consider next the effect of an increase in the cost of R&D on innovation and disclosure:

$$\frac{dx}{d\xi} = \frac{\beta\gamma_{x\xi}\theta''(\alpha)z(\eta)z(\alpha) - [\gamma_x\gamma_\xi(1-\delta)^2]}{F\beta\theta''(\alpha)z(\eta) + [\gamma_x(1-\delta)]^2} < 0. \quad (22)$$

The numerator is positive by Axiom 1, while the denominator is negative by (14). As expected, an increase in the cost of R&D reduces R&D investment. As for the effect on expensing, we have that:

$$\frac{d\alpha}{d\xi} = \frac{(\delta-1)\left[\gamma_\xi + \gamma_x\frac{dx}{d\xi}\right]}{\beta\theta''(\alpha)z(\eta)}. \quad (23)$$

The first term in the numerator is negative, the denominator is positive, while the sign of the second term in the numerator is ambiguous. As a consequence, an increase in the cost of R&D has an ambiguous effect on reporting. The first term in the numerator represents the direct effect of an increase in ξ on α . For a given level of R&D, R&D expenditures have gone up, which pushes expensing down. The second term in the numerator represents the indirect effect of R&D investment on α . The increase in ξ reduces x , which has a positive effect on expensing. Depending

on which effect dominates, expensing may increase or decrease with the increase in R&D costs.

Because a reduction in the cost of R&D is equivalent to an R&D subsidy, this result implies that subsidies have an ambiguous effect on expensing. In a sense there is some contradiction between subsidizing R&D while forcing firms to adopt a policy of immediate expensing or at least to expense R&D faster than its benefits occur. Expensing has a negative effect on innovation. From that perspective, a more generous stand toward capitalization can be seen as a (free) way of subsidizing R&D.

Finally, consider the effect of an increase in the cost of capitalization:

$$\frac{d\alpha}{d\beta} = -\frac{\theta'(\alpha)}{\beta\theta''(\alpha) + \frac{[\gamma_x(1-\delta)]^2}{Fz(\eta)}} > 0. \quad (24)$$

The numerator is negative, while the denominator is positive by (14). As expected, an increase in the cost of capitalization increases expensing. There is also an effect on R&D investment:

$$\frac{dx}{d\beta} = -\frac{\gamma_x(1-\delta)}{F} < 0. \quad (25)$$

The numerator is positive, while the denominator is negative, implying that the increase in the cost of capitalization, because it increases expensing, reduces R&D investment. Again, this is due to the strategic substitutability between expensing and innovation.

Table 1. Effects of Parameters on R&D Expenditures and Expensing

	R&D Output (x)	Expensed Portion of R&D Investment (α)
Short-Term Benefits of R&D		
(λ)	+	-
Initial Marginal Cost		
(R)	-	+
Demand		
(A)	+	-
Short-Term Cost of Capitalization		
(η)	-	+
Discount Factor		
(δ)	+	\pm
R&D Cost		
(ξ)	-	\pm
Cost of Capitalization		
(β)	-	+

Proposition 4: An increase in the cost of capitalization decreases innovation and increases expensing.

Table 1 summarizes the comparative statics of the model. Appendix 1 solves the model using explicit functional forms, confirming the results derived above.

4. Conclusions

This paper presents a formal model of the decision of firms to expense or capitalize R&D expenditures. That decision is found to depend on a number of variables, including the short-term benefits of R&D, the discount factor, R&D costs, firm size, and demand. Overall, there is strategic substitutability between R&D expenditures and expensing. Moreover, accounting standards and the market's perception of the quality of the firm's profits can have real effects on innovation. The finding of a potentially positive impact of looser accounting standards on innovation is in accordance with the empirical findings of Elliott et al. (1984) and Horwitz and Kolodny (1980). Horwitz and Kolodny (1980) find that the change in standards in 1974 in the U.S. led to a reduction in R&D investments by small high-tech firms, which were using capitalization.

The model suggests that accounting rules have real effects on R&D spending. Markoff (1990) even argues that U.S. manufacturing firms are not competitive internationally because of their concern that R&D investments will reduce current earnings significantly. Hence an immediate expensing policy seems to aggravate the well-known excessive concern of U.S. managers with the short-term versus the long-term. Further evidence that accounting policy affects R&D investments is provided by Baber et al. (1991), who find that R&D spending is lower when spending may cause the firm to report negative profits or lower levels of profits compared to the previous period. They conclude that in the U.S. the immediate expensing rule induces firms to manipulate R&D spending to achieve particular levels of net income. The interaction between R&D spending and accounting policy calls for a better control for the endogeneity of R&D expenditures in empirical studies of capitalization. Similarly, Mulkay et al. (2000) find that R&D investments by U.S. firms are more sensitive to cash flow and profits than they are for French firms. They trace this difference back to differences in the functioning of capital markets between the two countries, with U.S. share ownership being more segmented and more volatile, which makes U.S. firms more responsive to news about their prospects.

Two immediate extensions of the model can be useful. First, the study of the capitalization decision in a market composed of many firms can illustrate how firms' accounting policies interact. Second, with an explicit solution for the expensing degree (α), it would be possible to compare the degree of expensing with the speed with which the benefits of R&D occur (λ), i.e., to compare the distribution of R&D benefits and (reported) costs over time. More generally, detailing the sources of the negative response of markets, by opening up the function $\theta(\alpha)$, would increase the

transparency of the model and of the results.

Appendix 1

In this appendix the results are derived using explicit functional forms as a check on the results derived in the paper. Consider the following explicit functional forms, which satisfy the assumptions of the paper:

$$\begin{aligned}\gamma(\xi, x) &= (\xi x)^2, \\ \theta(\alpha) &= (1 - \alpha)^2.\end{aligned}$$

The first-order conditions (9) and (10) become:

$$\frac{\partial \pi_T}{\partial x} = \frac{\lambda(A - R + \lambda x) + \delta(A - R + x)}{2} - 2\xi^2 x(\alpha + \delta(1 - \alpha)) = 0, \quad (26)$$

$$\frac{\partial \pi_T}{\partial \alpha} = \xi^2 x^2 (\delta - 1) + 2\beta(1 - \alpha)(\eta + \delta(1 - \eta)) = 0. \quad (27)$$

The comparative statics are:

$$\frac{dx}{d\lambda} = -\frac{0.5(A - R) + \lambda x}{F + \frac{[2\xi^2 x(1 - \delta)]^2}{2\beta z(\eta)}} > 0, \quad (28)$$

where

$$\begin{aligned}F &= 0.5(\lambda^2 + \delta) - 2\xi^2 z(\alpha) < 0, \\ \frac{d\alpha}{d\lambda} &= \frac{2\xi^2 x(\delta - 1)}{2\beta z(\eta)} \frac{dx}{d\lambda} < 0,\end{aligned} \quad (29)$$

$$\frac{dx}{dR} = \frac{0.5(\lambda + \delta)}{F + \frac{[2\xi^2 x(1 - \delta)]^2}{2\beta z(\eta)}} < 0, \quad (30)$$

$$\frac{d\alpha}{dR} = \frac{2\xi^2 x(\delta - 1)}{2\beta z(\eta)} \frac{dx}{dR} > 0, \quad (31)$$

$$\frac{d\alpha}{d\eta} = -\frac{-2(1 - \alpha)\beta(1 - \delta)}{\frac{[2\xi^2 x(1 - \delta)]^2}{F} + 2\beta z(\eta)} > 0, \quad (32)$$

$$\frac{dx}{d\eta} = \frac{2\xi^2 x(1 - \delta)}{F} \frac{d\alpha}{d\eta} < 0, \quad (33)$$

$$\frac{dx}{d\delta} = -\frac{2\beta z(\eta)[0.5(A-R+x)-2\xi^2 x(1-\alpha)]+2\xi^2 x(1-\delta)[\xi^2 x^2+2(1-\alpha)\beta(1-\eta)]}{2F\beta z(\eta)+[2\xi^2 x(1-\delta)]^2} > 0, \quad (34)$$

$$\frac{d\alpha}{d\delta} = \frac{\xi^2 x^2 + 2(1-\alpha)\beta(1-\eta) + 2\xi^2 x(\delta-1)\frac{dx}{d\delta}}{2\beta z(\eta)} > 0 \text{ or } < 0, \quad (35)$$

$$\frac{dx}{d\xi} = \frac{8\xi x\beta z(\eta)z(\alpha) - [2\xi^2 x(1-\delta)][2\xi x^2(1-\delta)]}{2F\beta z(\eta) + [2\xi^2 x(1-\delta)]^2} < 0, \quad (36)$$

$$\frac{d\alpha}{d\xi} = \frac{2\xi x^2(\delta-1) + 2\xi^2 x(\delta-1)\frac{dx}{d\xi}}{2\beta z(\eta)} > 0 \text{ or } < 0, \quad (37)$$

$$\frac{d\alpha}{d\beta} = \frac{2(1-\alpha)}{2\beta + \frac{[2\xi^2 x(1-\delta)]^2}{Fz(\eta)}} > 0, \quad (38)$$

$$\frac{dx}{d\beta} = -\frac{2\xi^2 x(1-\delta)}{F} < 0. \quad (39)$$

All the comparative statics are consistent with those obtained using general functional forms.

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